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WINTERING RAPTOR USE OF HYBRID POPLAR PLANTATIONS IN NORTHEASTERN OREGON

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Abstract.—We studied wintering raptor use of hybrid poplar (*Populus* spp.) plantations in comparison to surrounding cover types in the Columbia Basin of northeastern Oregon. Diurnal raptors were surveyed in shrub-steppe, poplar plantations, and irrigated croplands. Logistic regression analyses suggested that the three most common raptors, Red-tailed Hawks (*Buteo jamaicensis*), American Kestrels (*Falco sparverius*), and Northern Harriers (*Circus cyaneus*) were associated with croplands, interiors of 1-yr-old plantations, and plantation edges. Shrub-steppe was also selected as a significant predictor of sites with American Kestrels. The best model for the Northern Harrier also included the interior of 2-yr-old plantations, but excluded croplands and edges of older plantations. Plantations and plantation edges appeared to be used by wintering raptors disproportionately to their availability. Our data suggest that maximizing plantation edges and managing for a variety of plantation ages within this landscape will likely provide suitable habitat for wintering raptors in this region.

Key Words: *American Kestrel;* Falco sparverius; *Northern Harrier;* Circus cyaneus; *Red-tailed Hawk;* Buteo jamaicensis; *cropland; hybrid poplar;* Populus *spp.; shrub-steppe.*

USO DE PLANTACIONES DE ALAMO HÍBRIDO POR RAPACES DURANTE EL INVIERNO EN EL NORORIENTE DE OREGON

Resumen.—Estudiamos el uso por rapaces durante el invierno de plantaciones de álamo híbrido (*Populus* spp.) en comparación a los tipos de cobertura de los alrededores en la cuenca del Columbia en el nororiente de Oregon. Las rapaces diurnas fueron estudiadas en plantaciones, campos irrigados y hábitats de estepas arbustivas. El análisis de regresión logística sugiere que la mayoría de rapaces están asociadas con los campos, los interiores de las plantaciones de un año, y los bordes de las plantaciones. La estepa arbustiva fue seleccionada además como un pronosticador efectivo del cernícalo (*Falco sparverius*). El mejor modelo para el aguilucho norteño (*Circus cyaneus*) incluyó además los interiores de plantaciones de 2 años de edad, pero excluyo los campos y bordes de plantaciones más viejas. Las plantaciones parecieron ser un hábitat importante para rapaces invernantes, especialmente como sitios de percha. Nuestros datos sugieren que para la mayoría de especies, maximizar los bordes de las plantaciones y proveer una variedad de edades en la plantación dentro de este paisaje probablemente proporcionará el mejor hábitat para las rapaces durante el invierno.

[Traducción de César Márquez]

The development of short-rotation woody crop (SRWC) plantations in North America is becoming increasingly common with the forest-products industry due to the fast-growing nature of these trees. Nearly 80 000 ha of SRWC plantations have been established in the United States, and over 69 million ha have been identified as suitable for SRWC plantations (Alig et al. 2000). Although a variety of tree species are grown in these plantations, hybrid poplars (*Populus* spp.) are the most commonly planted species in the Pacific Northwest. In the past 15 yr, over 28 000 ha of poplar plantations have been established in the Pacific Northwest to produce fiber for paper and dimensional lumber products (Heilman et al. 1995). Poplars are also used in conservation plantings, as buffers along riparian areas, and in phytoremediation projects across North America (Isebrands 2000).

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Little is known about the habitat value of these plantings for raptors. However, Bogliani (1988), Prater (1993), Bogliani et al. (1994), Sergio and Bogliani (2000) have examined bird use of poplar plantations in Europe. Bogliani et al. (1994) and Sergio and Bogliani (2000) reported that poplar plantations supported nesting Eurasian Hobby (*Falco subbuteo*) densities of up to one pair per 50 km^2. Prater (1993) also commented that poplar plantations provided hunting habitat for the Barn Owl (*Tyto alba*) in Great Britain. Moreover, Schmitz (1986) demonstrated that Common Buzzards (*Buteo buteo*) used poplar plantations in Belgium, although at lower relative densities than other bird species.

Fewer studies have examined raptor use of poplar plantations in North America. Moser (2002) found that nine Northern Saw-whet Owl (*Aegolius acadicus*) pairs nested successfully in poplar plantations when 25 nest boxes were provided. Christian et al. (1997) studied bird use of poplar plantations in the Midwest in comparison to bird use of surrounding croplands and natural forests. They reported Red-tailed Hawks (*Buteo jamaicensis*) used forests adjacent to plantations, but were not found in the plantations.

Because poplar plantations commonly replace cropland, and sometimes native habitat, it is important that we understand the use of these plantations by wildlife. The objective of our study was to determine which cover types were the best predictors of raptor abundance in a landscape dominated by shrub-steppe, poplar plantations, and croplands in northeastern Oregon.

STUDY AREA

The 20 105 ha study area was a complex of poplar plantations and irrigated croplands, surrounded by shrub-steppe vegetation (Franklin and Dyrness 1988) in the Columbia Basin of northeastern Oregon. Shrub-steppe, plantation, and cropland cover types comprised 47%, 35%, and 18% of the study area, respectively. The area contained relatively high densities of primitive roads in plantations and croplands (>1.9 km/km^2), and lower densities in shrub-steppe (<1 km/km^2). Topography varied from flat to slightly undulating and elevations ranged from 150–250 m. Mean annual precipitation was ca. 22 cm (Ruffner 1978).

Shrub-steppe vegetation varied depending on soil type (Franklin and Dyrness 1988). The Quincy sand soil types were dominated by indian ricegrass (*Oryzopsis hymenoides*), needle-and-thread (*Stipa comata*), and antelope bitterbrush (*Purshia tridentata*). The finer soils were dominated by basin big sagebrush (*Artemisia tridentata*), bluebunch wheatgrass (*Pseudoregnaria spicatum*), Idaho fescue (*Festuca idahoensis*), and Sandberg's bluegrass (*Poa sandbergii*). This vegetation was also found in undisturbed, unfarmed corners (<2 ha each) surrounding agricultural circles. Corners that had been mowed or cultivated were usually dominated by invader species such as cheatgrass (*Bromus tectorum*) and Russian thistle (*Salsola kali*), or planted with a cover crop such as wheat Perch sites were relatively scarce in this cover type, and when available consisted of power poles, fence posts, and shrubs.

Drip-irrigated plantations were first established in 1994, primarily on former croplands irrigated by center-pivot systems. Plantations representing six age classes of trees (1–6-yr-old) were available for study. All trees were planted on ca. 2.5 × 3 m spacing and scheduled for harvest within 8–12 yr. Plantations differed in both tree height and understory composition depending on age. On average, poplars grew 3–5 m/yr. During the first 2–3 yr of growth, understory vegetation was often dense (>90% cover). Common understory plants included the native horseweed (*Conyza canadensis*) and redroot pigweed (*Amaranthus palmeri*), and several introduced invaders, including Russian thistle, tumble mustard (*Sisymbrium altissimum*), and cheatgrass. Each plantation was sprayed with an herbicide-mixture of glyphosate and 2,4-D, and cultivated once during yr one and two. However, most competing plants quickly recolonized given the favorable growing conditions, and impacts to rodent populations were short-term (Moser et al. 2002). Complete canopy closure occurred following yr three. At this time, the understory became nearly devoid of live plants (<5% cover) and was dominated by organic material primarily composed of leaf litter. Perch sites were abundant in all plantation age classes.

Agricultural fields in the study area contained a cover crop such as winter wheat, were fallow with wheat or corn stubble, or were planted with a perennial crop such as alfalfa or grass. These fields were not irrigated during the study period. Perch sites were more abundant than in shrub-steppe, but less abundant than plantation cover types and included hay stacks, power poles, small trees, and irrigation equipment.

METHODS

Cover types were surveyed with equal intensity, and included shrub-steppe, tree plantations by age-class (1–6-yr-old), and croplands. Tree plantations were further stratified into interior and edge categories, with the exception of 6-yr-old plantations, which due to limited area had only edge transects. Plantation-interior categories were bordered on all sides by plantations. Plantation-edge categories were defined as the convergence of plantations and either shrub-steppe or cropland cover types These habitat cover types used in the analysis are described in Table 1.

We conducted road surveys through the center of each of the cover type categories once per week during January and February, for a total of eight surveys in 1999 and nine in 2000. Primitive road sections were classified as either containing powerlines or not, and road sections were randomly selected for surveys until each cover type had equal amounts of powerline-influenced road sections. Approximately 6.4 km of transect was selected as

Table 1. Indicator variables used in the development of logistic regression models for wintering raptors in northeastern Oregon, 1999 and 2000.

VARIABLE	DESCRIPTION
YR	1999 or 2000
NAT	Shrub-steppe habitat
AG	Irrigated cropland
I1	Interior of 1-yr-old plantations
I2	Interior of 2-yr-old plantations
I3	Interior of 3-yr-old plantations
I4	Interior of 4-yr-old plantations
I5	Interior of 5-yr-old plantations
E1	Edge of 1-yr-old plantations
E2	Edge of 2-yr-old plantations
E3	Edge of 3-yr-old plantations
E4	Edge of 4-yr-old plantations
E5	Edge of 5-yr-old plantations
E6	Edge of 6-yr-old plantations

four 1.6 km sections of road in each of the cover types. Transects were located ≥0.8 km apart to reduce the probability of sampling the same bird twice (Fuller and Mosher 1987). Birds detected within 100 m of the transect were assumed to be using that cover type. Surveys were conducted between sunrise and 1100 H. Successive surveys were conducted in opposite directions to reduce any time-of-day bias. Surveys were conducted from a vehicle by two trained observers (all observers had a minimum of a B.S. in Wildlife Biology and were trained formally during a 5-d period to identify local raptors and to conduct surveys) to identify local raptors while using binoculars and spotting scopes to aid in raptor identification. The vehicle was traveling continuously at 10–30 km/hr, depending on visibility within each cover type. Raptor detection rates were influenced by both survey effort (i.e., time) and visibility. In general, visibility was greatest in shrub-steppe and croplands, and decreased with increasing plantation age. Therefore, we adjusted vehicle speed so that it was greater in open cover types, and slower in dense cover types. Although this methodology resulted in greater survey time in older plantations, we felt any survey effort bias was appropriately offset by the lower detection rates of birds in the heavier cover types (Millsap and LeFranc 1988). We stopped the vehicle to identify birds when necessary (Fuller and Mosher 1987). Surveys were not conducted during inclement weather (Ralph et al. 1993).

All birds, whether perched or flying, were recorded and included in the analyses as using a particular cover type for two reasons. First, although most of the species we studied hunt primarily from perches, many of them will also hunt while flying. Two of the three most common raptors we observed (Red-tailed Hawk and American Kestrel) hunt from both a perch and while flying (Preston and Beane 1993, Smallwood and Bird 2002). Furthermore, the Northern Harrier (*Circus cyaneus*) hunts almost exclusively while flying (MacWhirter and Bildstein 1996). Second, we were not always able to determine whether we flushed a bird as we approached its perch, or whether it was flying before we detected it. Therefore, we assumed that if a bird was detected perched in or flying through a cover type, that it was using that cover type.

Chi-square goodness-of-fit analysis of the count distribution indicated the data were not normally distributed, but rather conformed to the geometric distribution ($P > 0.05$). Attempts to transform the data to a normal distribution failed due to the low-frequency of the transect counts, the discrete nature of count data, and the prevalence of transects with no raptor detections. Thus, the count data for each species were converted to a presence/absence variable, and multiple logistic regression was used to determine the elements of the experimental design that contributed significantly to raptor presence. Logistic regression with indicator variables provides insight into the magnitude of effects of individual habitat attributes on raptor presence through the relative value of the coefficient estimate. Coefficient estimates with higher values indicate habitats with a higher probability of raptor presence. Sufficient observations existed to develop individual regression models for Red-tailed Hawk, Northern Harrier, and American Kestrel. Count data were coded according to habitat attributes using indicator variables (Table 1). Additionally, a temporal variable (YR) was included to determine the significance of year to the survey as this was an initial element of the experimental design (Table 1). Because raptor counts were generally higher in 1999 than in 2000, the YR variable was coded as 1 for 1999, and 0 for 2000. Thus, each analysis of habitat associations contained 14 indicator variables. Parameter estimates were developed using Maximum Likelihood estimation (StatSoft, Inc. 1995). Indicator variables for $P > 0.05$ were removed individually until only significant variables remained in the model. All analyses were performed with Statistica for Windows (StatSoft, Inc. 1995).

The classification ability of each model was tested by randomly sub-sampling 25% of the original data. The predicted values for each model were then compared to the observed values for this sub-sample. It should be noted that these data were used in the original model development, and cannot be considered independent. Nevertheless, they still provided some information on the classification ability of the models.

RESULTS

We detected 374 diurnal raptors of 12 species during 1999 and 2000 (Table 2). The most common raptors were Red-tailed Hawk, Northern Harrier, and American Kestrel. Species detected at relatively low rates included Rough-legged Hawk (*Buteo lagopus*), Ferruginous Hawk (*B. regalis*), Northern Goshawk (*Accipiter gentilis*), Cooper's Hawk (*A. cooperii*), Sharp-shinned Hawk (*A. striatus*), Golden Eagle (*Aquila chrysaetos*), Prairie Falcon (*Falco mexicanus*), Merlin (*F. columbarius*), and Snowy Owl (*Nyctea scandiaca*). All but the Prairie Falcon were observed at least once within a plan-

Table 2. Total raptor detections by cover type in northeastern Oregon, 1999 and 2000.

	COVER TYPE[1]														
	NAT	AG	E1	E2	E3	E4	E5	E6	I1	I2	I3	I4	I5	TOTAL	PERCENT PERCHED
Total	11	49	17	21	35	57	68	42	49	11	6	6	2	374	89.2
Red-tailed Hawk	1	21	5	4	15	28	44	20	6	2	0	2	1	149	86.8
Northern Harrier	1	6	7	6	1	10	6	2	27	7	4	3	0	80	26.6
American Kestrel	3	17	2	11	11	9	9	6	7	0	0	0	0	75	89.5
Rough-legged Hawk	4	2	1	0	5	3	5	2	1	0	0	0	0	23	87.3
Cooper's Hawk	0	0	0	0	0	3	0	0	2	1	1	0	0	7	100.0
Ferruginous Hawk	0	0	0	0	0	0	0	6	0	0	0	0	0	6	83.3
Golden Eagle	1	0	1	0	0	0	1	0	2	0	0	0	0	5	100.0
Sharp-shinned Hawk	0	0	0	0	0	0	1	1	1	0	0	0	0	3	100.0
Snowy Owl	0	1	0	0	0	0	0	0	1	0	0	0	0	2	100.0
Merlin	1	0	0	0	1	0	0	0	0	0	0	0	0	2	100.0
Prairie Falcon	0	1	0	0	0	0	0	0	0	0	0	0	0	1	100.0
Northern Goshawk	0	0	1	0	0	0	0	0	0	0	0	0	0	1	100.0
Unidentified raptor	0	1	0	0	2	4	2	5	2	1	1	1	1	20	85.5

[1] See Table 1 for description of cover types.

Table 3. Logistic regression models used to identify cover types significant to raptor presence in northeastern Oregon, 1999–2000. All regression models are significant ($P \leq 0.001$).

DEPENDENT VARIABLE	INTERCEPT	INDICATOR VARIABLE	COEFFICIENT	P
Red-tailed Hawk	−3.92	AG	2.89	<0.001
		I1	1.58	0.001
		E1	1.54	0.003
		E2	1.45	0.008
		E3	2.37	<0.001
		E4	3.24	<0.001
		E5	3.74	<0.001
		E6	3.46	<0.001
Northern Harrier	−3.25	I1	2.22	<0.001
		I2	0.93	0.008
		E1	1.07	0.002
		E2	1.23	<0.001
		E4	1.23	<0.001
American Kestrel	−5.40	NAT	1.89	0.004
		AG	3.55	<0.001
		I1	2.81	<0.001
		E2	3.32	<0.001
		E3	3.23	<0.001
		E4	2.96	<0.001
		E5	3.10	<0.001
		E6	3.79	<0.001
		YR	0.78	<0.001

[1] See Table 1 for description of indicator variables.

tation. Most of the raptors detected (except for Northern Harriers) were observed on a perch (Table 2).

Logistic regression models developed for Red-tailed Hawk, Northern Harrier, and American Kestrel, were all significant ($P < 0.001$; Table 3). The cover type categories selected as contributors to predictability of Red-tailed Hawk presence were AG, I1, and E1–E6 ($P < 0.008$; Table 3). Cover type categories selected for the Northern Harrier model included AG, I1–I2, and E1–E2, and E4 ($P = 0.008$; Table 3). The cover type categories selected as contributors to predictability of American Kestrel presence were NAT, AG, I1, and E1–E6 ($P = 0.004$; Table 3). The I3–I6 cover type categories were not selected for any model ($P > 0.05$). Survey year was a significant component for the American Kestrel model only. More Kestrels were detected in 1999 than in 2000 ($P < 0.001$; Table 3). The indicator variables selected for inclusion or exclusion in the logistic models correctly predicted raptor presence 92% of the time within 10% of the observed rate. Variables that did not classify as well included AG and E4 for the Red-tailed Hawk model, and I1 for the Northern Harrier model (Table 4).

DISCUSSION

Although we detected 12 species of raptors in this study, only three were detected frequently enough to be considered common. All of the hab-

Table 4. Predicted versus observed classification rates of logistic regression models for Red-tailed Hawk (RTHA), Northern Harrier (NOHA), and American Kestrel (AMKE) presence in various cover types.

Indicator Variable	Predicted Rate			Observed Rate		
	RTHA	NOHA	AMKE	RTHA	NOHA	AMKE
NAT	0.00	0.00	0.03	0.00	0.00	0.00
AG	0.26	0.00	0.14	0.07	0.00	0.07
I1	0.09	0.26	0.07	0.13	0.38	0.13
I2	0.00	0.09	0.00	0.00	0.05	0.00
I3	0.00	0.00	0.00	0.00	0.07	0.00
I4	0.00	0.00	0.00	0.06	0.00	0.00
I5	0.00	0.00	0.00	0.00	0.00	0.00
E1	0.09	0.10	0.00	0.00	0.11	0.00
E2	0.08	0.12	0.11	0.07	0.14	0.07
E3	0.18	0.00	0.10	0.18	0.00	0.09
E4	0.34	0.12	0.08	0.50	0.13	0.06
E5	0.46	0.00	0.09	0.45	0.00	0.09
E6	0.39	0.00	0.17	0.42	0.00	0.25

[1] See Table 1 for description of indicator variables.

itats studied were used by at least one raptor species. However, raptor distribution was most affected by croplands and poplar plantations in this study. In fact, only American Kestrel distribution was significantly affected by native shrub-steppe habitat. Our results are not surprising, as a number of other studies have reported relatively high numbers of certain raptor species in agricultural landscapes (Parker and Campbell 1984, Craig et al. 1986, Meunier et al. 2000), probably due to both a large number of available perch sites (e.g., utility poles) as well as relatively high densities of small mammal prey in these settings. The distribution of utility lines and poles within treatment categories in our study was intentionally made equal so as not to confound the results. Nevertheless, plantations still provided significantly more perch sites than shrub-steppe or even cropland cover types. Thus, it is not surprising that most raptors were more commonly detected in or near plantations. Furthermore, prey densities are relatively high in both croplands and young poplar plantations (Christian et al. 1997, Moser et al. 2002). Because most Red-tailed Hawks and American Kestrels were detected on perches, it is likely they were hunting in those habitats (Preston and Beane 1993, Smallwood and Bird 2002). Likewise, most Northern Harriers were detected flying, again suggestive of hunting behavior for this species (MacWhirter and Bildstein 1996).

Hanowski et al. (1997) found that surrounding cover types affected songbird use of hybrid poplar plantations in the midwestern U.S. We believe this phenomenon to be true in our study as well. Raptor detections were generally greatest along the edges of plantations when compared to the interiors, with the exception of the Northern Harrier which commonly hunts in open, brushy habitats, similar to those provided by the younger plantations. Most of the birds studied were not well adapted to hunting in the dense plantation habitats, with the exception of the *Accipiter* spp. The edge habitat created by the convergence of plantations with cropland and shrub-steppe habitats provided ideal hunting areas by providing perch sites near open habitat suited for prey species such as rodents.

Raptors contribute to important ecosystem processes, such as predator-prey dynamics (Hanski et al. 1991), and thus may be important in dampening the effects of nuisance rodent outbreaks (Korpimäki and Norrdahl 1991). In addition, these birds may be indicators of ecosystem quality due to their high-trophic-level status. Due to the ecological and economic importance of this bird assemblage, it is important that plantation managers consider these birds when designing and managing plantations. Due to the affinity of raptors toward both the interiors and edges of plantations, maintaining a diversity of plantation ages and creating within-plantation heterogeneity (Hanowski et al. 1997) will provide more structural diversity and edge, and thus likely create more favorable habitat for wintering raptors.

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